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ABSTRACT

This project investigated the quality of the planetarium as a teaching device by contrasting the performance of students taught in the planetarium with the performance of those taught in regular classrooms. Data for the study derived from official records of Cerritos and El Camino community college students enrolled in introductory astronomy for spring 1975. Performance assessment involved comparing three planetarium and non-planetarium student sub-groups: (1) by high, medium, or low academic ability as indicated by mean community college grade point average (3.0 or higher, 2.0-2.9, and less than 2.0); (2) by sex; and (3) by age. Performance criteria included grades on homework, unit tests, mid-term tests, and final course grades. Of the 135 planetarium students, 28% received grades of A, 40% grades of B, 15% grades of C, and 15% grades less than C. Of the 106 non-planetarium students, 11.3% had grades of A, 30% grades of B, 25% grades of C, and 34% grades less than C. Planetarium instruction was positively significant for low, medium, and high ability students, for both males and females, and for all age groups examined (under 30, 30-39, and 40 or over). Data tables and a bibliography are included. (TR)

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The Value of the Planetarium as an Instructional Device

EDWARD D. ORTELL

A MAJOR APPLIED RESEARCH PROJECT
PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF EDUCATION

NOVA UNIVERSITY

1977

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EDWARD D. ORTELL: The Value of the Planetarium as an Instructional Device

ABSTRACT

The Pacific Planetarium Association, (PPA), an Astronomy education association, was formed in 1967. The investigator was a Charter Secretary of the association. The PPA reaches from Anchorage, Alaska to San Diego, California and from Denver, Colorado to Honolulu, Hawaii. The PPA has often pondered the question: Does the planetarium has an educational value or is its primary function entertainment? The purpose of this study was to determine the quality of the planetarium as a teaching device. Are students taught in the planetarium significantly higher in performance than those taught in the regular classroom.

The planetarium's effectiveness opposed to the regular classroom was assessed by analyzing student academic performance. The criteria for academic performance contrasted in the areas of (1) three mean grade point average groups (2) male-female groups and (3) three age groups. Students who entered Cerritos and El Camino Community Colleges in the fall, 1974 and enrolled in introductory astronomy in the spring, 1975 were used.

Student transcripts were examined to obtain data about performance. In order to compare the groups on the selected criteria, hypotheses were formulated and tested by analyses of variance and chi-square analyses, with .05 as the acceptable probability level. For tables eighteen to thirty-five the t-test was used.

The results indicated that the performance of planetarium instruction was consistently higher to that of regular classroom instruction, and statistically significantly so in twenty-three of forty-eight areas. There was significantly higher performance found in the three age groups in the planetarium students. There was significant difference between male or female groups in the academic performance of planetarium students. The greatest effects the planetarium instruction had were in the grade point average groups and especially in the three-point grade point average or above group.

The conclusions were the planetarium instructed students consistently performed at higher quality and significantly so in many of the groups.

Based on these conclusions support for planetarium instruction should be continued. Additional astronomy courses should be offered in the planetarium with special consideration for the high ability student. It is advised that colleges with planetariums conduct workshops for instructors whose colleges do not have planetariums, and that planetarium instructors incorporate features into planetariums that will enable students of low ability to gain more meaningful instruction.

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CHAPTER 1

INTRODUCTION TO THE STUDY

The Pacific Planetarium Association (PPA) is an educational association of astronomy instructors. It is bounded by Anchorage on the north, San Diego on the south, Denver on the east, and Honolulu on the west. Community college astronomy instructors who are members of this organization have often voiced the need for research to answer the following questions. Is there justification for the planetarium as a teaching instrument? Since many colleges use the planetarium not only for instruction, but for entertainment as well, is the planetarium a ploy for filling classes? The community colleges of the Pacific Planetarium Association reported introductory astronomy classes were the first to fill. Increased student demand for astronomy classes has resulted from "the walk on the moon", space shots such as Pioneer and Mariner, and related astronomical events which have aroused major public interest.

All of the community colleges of the Pacific Planetarium Association have experienced rapid growth since the organization was chartered in 1967. The Pacific Planetarium Association area community colleges' total enrollment increased from one million in fall, 1960 to over two million by fall, 1975. The community college has a commitment to serve the entire community and an open admission policy; thus it has accepted a significant number of low ability and educationally-disadvantaged students. To meet the needs of these students, the

colleges have at various times established remedial courses, reading and writing labs, and special programs. The building of a well-equipped planetarium and observatory utilizing federal funds was part of such a program.

The increase in the number of students with academic deficiencies entering community colleges is a problem of great concern for the faculty and administration. The survival of students with skill deficiencies depends in part on the success of special teaching devices and such services that teachers can design to assist them with their various academic problems. Thus the question remains: Are funds spent on an expensive planetarium justified by improved academic performance, particularly among those students with skill deficiencies?

An analysis of the existing astronomy student population in the Pacific Planetarium Association area revealed a moderate probability of success for those entering freshmen whose high school grade point averaged 2.00 or better. In a study completed in 1964, Gardner evaluated the elementary astronomy program at various community colleges. After analyzing the data gathered from a sample of college freshman astronomy students, he concluded:

> The planetarium has demonstrated that for all practical purposes the elementary astronomy program at the community college does produce meaningful differences in student withdrawal from science courses, is effective in raising the science grade, often results in achievement at a higher level in other courses, and is effective in improving the writing of science papers or reading the more technical journals. (Gardner, 1964, p. 17.)

Gardner's findings about science grades and attrition indicated that colleges with planetariums and desirable astronomy offerings were meeting the needs of students not previously interested in the physical sciences.

The Pacific Planetarium Association has in the past recommended substantial changes in astronomy course offerings and teaching methods to meet the needs of the community college astronomy student. It is stressed that "labeling a student as an astronomy student gives him a sense of belonging which affects the student's motivation, self-concept, and emphasizes his strengths and experiences of success" (Burrill, 1971, p. 28.) The Pacific Planetarium Association recommends that astronomy departments develop courses to meet the needs of a community college astronomy student population that is heterogeneous in ability, race, sex, and age. Astronomy courses should stress building on individual strengths rather than emphasizing a person's weaknesses, should allow students to be responsible for their own academic growth in astronomy, should develop the total human being with the opportunity to interact in his real world as well as in the astronomical discipline, and should not simply provide traditional content material from the field of astronomy.

PURPOSE OF THE STUDY

The purpose of this project was to investigate the quality of the planetarium as a teaching device. Is there a significant difference in performance between those students taught in the

planetarium and those taught in the regular classroom? In the investigation of this question, student academic performance was analyzed in three areas. Criteria of academic performance were formulated to analyze: (1) achievement according to grade point averages. The high grade point student in the planetarium was compared to the high grade point student in the classroom. The medium grade point students were compared to medium grade point students and low grade point students to low grade point students in the same manner. All comparisons were based on community college grade point averages; (2) achievement according to sex. Planetarium-taught males were compared to classroom-taught males and the same for the females, and (3) achievement according to age. The under-thirty students in the planetarium were compared to the under-thirty students in the classroom. Comparisons were also made with the thirty to thirty-nine and forty and older age groups. Each of the three criteria included comparisons of planetarium-taught classes vs. regular classroom-taught classes.

The following questions were addressed:

1. Was the academic performance of the students in the planetariums, as measured by grade point averages, significantly higher than the performance of comparable students taught in the regular classroom?

2. Was the academic performance of the planetarium students with grade points three-point and higher significantly higher than that of comparable students who were in the regular classrooms?

3. Was the academic performance of planetarium students whose grade points ranged from two-point to 2.99 significantly higher than that of comparable students in the regular classroom?

4. Was the academic performance of planetarium students whose grade point averages were below two-point significantly higher than that of comparable students in the regular classrooms?

5. Was the academic performance of male students who completed their introductory astronomy course in the planetarium significantly higher than that of comparable students who had been taught in the regular classroom?

6. Was the academic performance of female students who completed their introductory astronomy course in the planetarium significantly higher than that of comparable students who had been taught in the regular classroom?

7. Was the academic performance of planetarium students who were under thirty years of age significantly higher than that of comparable students in the regular classroom?

8. Was the academic performance of planetarium students who were from thirty to thirty-nine years of age significantly higher than that of comparable students in the regular classroom?

9. Was the academic performance of planetarium students who were forty years of age and over significantly higher than that of comparable students in the regular classroom?

SIGNIFICANCE OF THE STUDY

Senior astronomy instructors, those who have taught ten years or more, indicated that the need for a planetarium was evidenced by the high dropout rate of students in many astronomy courses. Although there are different reasons for student withdrawal, an important one is academic frustration on the part of students who lack the necessary interest. A solution to this problem can be found in allowing students to examine the real object or to examine a very good simulation. This type of learning is effective in helping students increase their

academic skills to the extent that they can achieve and not become discouraged and drop out of the course. Real object or simulation is vital to the growth and stability of most science courses offered by community colleges. (Glucksmann, 1976.)

There are forty-one planetariums in PPA-area community colleges. Several are currently in the proposal or construction phase. Most of the planetariums in the Pacific Planetarium Association, along with more than a hundred nationwide, are involved in community service work. Many elementary and secondary schools commonly use the community college planetarium for field trips that enrich the learning experience of the pre-college student. As part of the community services at El Camino College, approximately eleven thousand elementary and secondary school children have visited the planetarium in the past seven years to receive instruction in astronomy. Many elementary, intermediate, and high schools have science units in astronomy which sometimes are not adequately taught because many elementary and secondary school teachers feel there is inadequate equipment in their specific schools. In recent years, the adjacent school districts in the area of El Camino College have limited astronomy units to a visit to the El Camino College Planetarium. This service to the community has been, as the eleven thousand figure indicates, very popular with the various elementary and secondary schools surrounding the El Camino College campus. These visitations are funded by community services at El Camino College.

During science workshops, class visitations, and social occasions at El Camino, elementary and secondary administrators have expressed the opinion that planetariums are entertaining, not instructional. Thus, the impact of the community college planetarium has been slow in evolving as an educational tool. A primary reason for this lack of acceptance on the part of elementary and secondary administrators is that their experience with a planetarium has been with the large city-owned and operated planetariums, such as the Griffith Planetarium in Los Angeles or the Adler Planetarium in Chicago. In most cases, these planetariums present programs that are primarily designed to entertain. According to Sunal (1973), most community college planetariums are not of that category:

> The planetarium has increased greatly in number instead of disappearing from the scene as with many other inventions. Its greatest potential in the 1920's was seen as an educational tool. (Sunal, 1973, p. 7.)

A number of programs for students who scored low in science on scholastic aptitude tests have been implemented in community colleges in the last decade. Additionally, various types of astronomy courses have also been developed. (Chamberlain, 1962.) In some of the courses the planetarium taught students achievement differs essentially from the students researched by Chamberlain in that the planetarium taught courses were specifically designed for a heterogeneous population. The planetarium supporter assumes planetarium instruction would be valuable for both educationally disadvantaged and non-disadvantaged students who selected its learning mode.

Smith (1961) and Sunal (1973) did not obtain the same results in their research of the planetarium as an educational tool. Battaglini found no significant difference between students' success in his experimental and control groups. (p. 79) However, Soroka (1968, p. 57) found that at each college where a comparison could be made between students enrolled in the planetarium-observation (well-equipped) classrooms and those not enrolled, the planetarium students made significantly higher grades than did comparable students in the regular classrooms. It should be noted that the programs studied by Soroka closely resemble the planetarium classroom in structure and in methods used.

The longitudinal aspect of a study by Pananides (1969) concerned the problem of student success after departure from astronomy and entry into a rigorous math or science course following a planetarium taught course. Bomgren (1970) conducted such a follow-up study and found no significant difference between planetarium taught students and regular classroom students. Bomgren (1971) found that the academic performance of astronomy students dropped significantly when they entered rigorous math-science courses in their second year. The study proposed here should help determine whether the planetarium classroom, by maintaining a heterogeneous population, would reduce or remove this reentry shock. A future question to be answered might be: Is the reentry shock a result of the special nature of the planetarium classroom or rather of the homogeneous grouping of the nonscience-oriented students?

Perhaps the shock results in the move from homogeneity (non-science) in planetarium classes to the heterogeneity (of science-oriented students) in math and other science classes?

Apart from these broad issues, which have significance outside the Pacific Planetarium Association as well, the project's specific information is important for curriculum decision making at Pacific Planetarium Association community colleges. If the proposed study has discovered a value of significance for planetarium instruction then positive interpretations would provide community colleges with clearer bases for instituting observational and planetarium-oriented astronomy courses. The findings also support the expansion of astronomy courses and the incorporation of some of the Pacific Planetarium Association's features into more astronomy departments. In addition, the project suggests the need for more research into other aspects of science education. Finally, a possible long-range effect on the institutional level would be an increase in instructional support for observational astronomy, and consequently, an increase in the number of students served.

The project's findings could have some impact on the negative interpretation and serious doubts about the overall effectiveness of the planetarium. Although the planetarium might have a number of positive benefits for low-ability students, it would be difficult to justify its existence if the students were not at least as successful as students in the regular classroom group.

In summary, the planetarium can legitimately provide

entertainment with innovative and stimulating presentations. But a research program must be maintained to validate its pedagogical assumptions and practices, especially with regard to the success of its nonscience-oriented students. This study was designed primarily to evaluate the planetarium as a teaching device and secondarily to assess the future effectiveness of the planetarium.

BACKGROUND OF THE STUDY

In the Pacific Planetarium Association astronomy is in the physical science division in seventy-one community colleges, and in the mathematics division in eleven community colleges. It is a general science education program for a heterogeneous group of students. In the past, the Pacific Planetarium Association attempted to provide an alternative approach to the traditional astronomy classroom teaching. Many of the findings were used in this study. The Pacific Planetarium Association recommended that introductory astronomy be presented for a student population that is heterogeneous in scholastic aptitude, sex, race, and age.

A primary aim of this study is to determine if all students, regardless of scholastic ability and other characteristics can benefit more through planetarium instruction with opportunities for observation, individual and group learning, and astronomy communications skill-building.

Four broad program goals of astronomy instructors of the Pacific Planetarium Association have been identified:

1. The student will function effectively as an embryo scientist.

2. The student will become proficient in solving astronomical problems relating to his natural environment.

3. The student will become proficiant in solving astronomical problems relating to his social environment.

4. The student will communicate effectively layman astronomical topics.

This humanistic model for elementary astronomy emphasizes the individual student and focuses on his ability to function in his natural and social environment.

An astronomy or any science course presentation should be based upon the assumption that in most life situations no one answer may provide the solution to a given problem, but that most significant problems require information from many sources for satisfactory solutions. The individual must learn to integrate his knowledge to find solutions to his own problems if he is to function effectively. Thus, a related assumption is that learning is much more than a memorization of facts and theories. The discipline is not accepted as an end to itself. The instructional methods used by many Pacific Planetarium Association members emphasize experiential learning activities in which students can form and test hypotheses and can evaluate the results of their choices.

Perhaps the most important assumption among Pacific Planetarium Association personnel is that the educational institution should provide a humane learning environment. To this end, Pacific Planetarium Association instructors make every attempt to provide an atmosphere where students can pursue their goals

in a safe and nonthreatening manner. There must be an attempt to insure that the student can maintain his identity in a large institution and can form new and close relationships with his peers and with at least one technician, teaching assistant, or faculty member. The planetarium is a noncompetitive situation where a student, with the aid of his peers, can clarify his educational and personal goals, improve his human relations skills, and deal openly with his learning problems.

This study is a direct response to the challenge. Is the planetarium an effective teaching device? The belief that every individual in the community should have the opportunity to develop the skills necessary not only for survival in his particular culture and environment, but for his association as well. Specifically, this study hopes to represent a major commitment mostly to community colleges toward the improvement of general education in the science of astronomy.

DEFINITION OF TERMS

The following terms are defined according to their use in this study:

CERRITOS STUDENT

The astronomy student from Cerritos Community College. His classroom was a regular one consisting of blackboard, chalk, globe, charts, and projection equipment.

EL CAMINO STUDENT

The astronomy student from El Camino Community College.

His classroom was the Spitz A-4 Planetarium, plus regulation classroom equipment.

FINAL SEMESTER GRADE

This is the student's grade for the course. It was based upon homework, unit tests, and mid-term test. Its significance was t-tested.

FULL-TIME STUDENT

A student who completed at least twelve semester hours of college credit during an academic fall or winter term.

GENERAL EDUCATION

Required core of courses. At most Pacific Planetarium Association community colleges, these are two semesters of English, Humanities, Social Science, and Natural Science.

G. P. A.

Average of community college grades, including both general education and elective specialization courses.

HOMEWORK

Those assignments, exercises, papers, and related work which the student is required to complete outside the classroom.

MID-TERM

The mid-term test was given on the material of the first two units. Its significance was t-tested.

OBJECTIVE

A statement of outcome; what the student will <u>do</u> as a result

of programmed self-teaching material, software and hardware.

PERFORMANCE

The student demonstrates his knowledge of the subject matter, and this falls into one of the following classifications.

A = 4.00, B = 3.00, C = 2.00, D = 1.00 and F = 0.00.

PLANETARIUM INSTRUCTION

Includes lecture and demonstration; special effects hardware; telescopes; spectroscopes; group discussion; and efforts by the student to demonstrate their knowledge of subject matter to learn by doing. To have opportunities for experimentation.

PPA

The Pacific Planetarium Association. An education association consisting mostly of community college astronomy instructors from Anchorage to San Diego and from Denver to Honolulu. It has approximately 100 members. It was formed to improve the quality of astronomy instruction. At PPA meetings the value of the planetarium as an instructional device is under current discussion.

PRACTICE

Provides ample opportunity for the student to engage in learning activities that will enable him to demonstrate his knowledge of the subject matter.

REGULAR CLASSROOM INSTRUCTION

Includes the use of lecture and discussion; use of blackboard, chalk and the common hardware such as globes and charts.

STATISTICAL SIGNIFICANCE

The probability level of .01 or less, used as indicative of statistical significance in analysis of variance and in chi-square analysis.

UNIT TESTS

A test given at the end of each unit, weighted at four times the homework, and scored in significance by the t-test.

STATEMENT OF THE PROBLEM

To date, the instructional possibilities of a planetarium have been barely investigated. An evaluation was needed involving a broadly based study which would:

1. List the objectives of a planetarium lesson in the context of perceived goals of planetarium educators.
2. Evaluate the effectiveness of the results of the planetarium lesson in terms of the perceived goals.
3. Compare the results of the planetarium lesson associated with related factors, concerning student and environmental characteristics, in terms of the perceived goals.

The problem investigated by this study was: Does the planetarium fulfill preconceived goals in education? The preconceived goals of planetarium educators for community college students in astronomy instruction were found to include the following:

> Significant favorable changes in performance, related to the objectives of planetarium instruction, are associated with a planetarium experience in the:

1. Knowledge, Comprehension and Application areas of the Cognitive domain.

2. Receiving, Responding and Valuing areas of the Affective domain.

3. Use of certain scientific skills, process skills, needed to accomplish particular objectives of the planetarium lesson.

The community college's transfer course policy is whether the programs developed and the education provided to individuals who otherwise would have been excluded from formal higher education are effective for students who wish to continue past the AA degree. In a period of economic recession, the acceptance of all applicants into the community colleges must be defensible both educationally and economically. On both the federal and the state levels, funding for many sectors of education, including the building of community college planetariums, has already been reduced or is in danger of being reduced. If state and local budgetary problems become more severe, it is quite possible that construction of more planetariums will be endangered. One logical method of curtailing expenses would be to limit enrollment or to limit costly construction, and the latter appears to be a more likely solution.

The community colleges have developed a variety of special programs for scientifically-inclined community college students, but the success of these programs is unclear. Studies by Roueche (1967) and Snyder and Blocker (1970) suggest that any student gains in developmental programs are temporary. More recently Roueche and Kirk (1973) studied several innovative materials which give greater evidence of positive and lasting results. Planetarium educators have supported attempts to provide enlightening astronomy courses that give positive and

lasting results for all students admitted, regardless of their previous academic success. The earlier efforts, special non-credit "astronomy to be enjoyed" courses that served as preparation for the required rigorous science courses, seventy percent of the members attending Pacific Planetarium Association 1975 fall conference were only partly successful and have since been discontinued. The Community College Space Studies Program at the Foothill and De Anza Campuses has had greater success and is still functioning, but a study initiated by Vincent (1967) and subsequent follow-up studies (Bomgren, 1971) revealed that, in general, students who entered the "astronomy to be enjoyed" type course were less successful than the accredited astronomy course student.

Pacific Planetarium Association advised that astronomy instructors recognize the special advantages available to students attending astronomy classes taught in the planetarium. It differs significantly from other modes of instruction since it deliberately includes techniques that will enable the student to gain visual concepts that may be restricted for the regular classroom student. The ultimate problem is to provide the opportunities and resources necessary for students of all abilities to be successful in community college astronomy courses. The problem of this project then is to evaluate the role of the planetarium in solving the ultimate problem.

GENERAL RESEARCH DESIGN

The data for this study were derived from the official spring, 1975 record files of Cerritos and El Camino Community Colleges, plus personally-developed materials by Pacific Planetarium Association instructors. A comparison of data from the two colleges was made to determine any significant differences between students with planetarium instruction and students in the regular classrooms.

In order to assess the performance, student subgroups were identified in both the planetarium classroom and the regular classroom. One subgroup consisted of those students whose grade point averages were three-point or higher in the elementary astronomy course, two-point to 2.99, and below two-point. Another subgroup was compared by sex. A third group was compared according to age. The identification of these subgroups allowed comparison both within and between the planetarium and the regular classroom. The significance of differences in grade point averages among subgroups and between the planetarium and the regular classroom was determined by analyses of variance using a .05 probability level of significance. Difference in grades earned were measured by chi-square analyses at a .05 level of significance.

LIMITATIONS OF THE STUDY

Both groups were studied starting in the spring, 1975. The period from the fall, 1974 to the end of spring, 1976, was selected for this study because it allowed students to be

followed over two complete academic years. While the students were from different colleges (Cerritos students in the regular classroom and El Camino students in the planetarium) the instructor was the same. Various checks on socio-economic and ethnic status indicate that the student body make-up of the two schools was nearly the same, i.e., El Camino was 70.5 percent Caucasian and Cerritos 71 percent Caucasian.

The planetarium class differs from the regular classroom in several important ways. The former offers a longer-established astronomy curriculum taught by more experienced astronomy faculty. The planetarium class curriculum emphasizes hardware teaching devices, includes specific learning objectives, stresses close faculty-student relationships, and supports the shared nature of the learning process. Among the diverse teaching strategies and activities used, experiential activities are especially encouraged. All of these characteristics point toward clearly defined educational goals. A complete evaluation of the planetarium classroom materials would certainly include an assessment of the degree to which these course goals are attained.

The instructor, however, did not deal with those factors which made the planetarium group different from the regular classroom. Of first importance in seeking a solution to the problem was to determine whether astronomy students were successful according to the ordinary norms used to measure academic success. This study used material suggested by only the objective criteria, thus limiting it to a partial course evaluation. This evaluation using norms accepted by most evaluators was essential for generalizing results that were comparable to those of studies.

CHAPTER 2

REVIEW OF RELATED LITERATURE

A careful search of Pacific Planetarium Association sources revealed many research papers that investigated planetarium and observatory education. In the late 1940's and early 1950's, research materials were mainly found in educational periodicals and astronomy journals.

Spitz (1950) wrote of preschools being encouraged to visit planetariums and stated planetarium visitations could supplement courses in astronomy, geography, meterology, and solid geometry. Several applications of the planetarium were first being investigated at that time.

Howe (1959) cited evidence that the planetarium could benefit the whole community by making people aware of scientific values and could develop individual talent and interest.

Nobel (1960) surveyed fifteen planetariums in 1960 and reported on the type of programs given to the various aged students. She also noted that no related activities such as evaluations or orientation sessions were carried out.

Gardner (1964) cited the dramatic impact of the planetarium which increased student retention as a valuable new scientific tool for teaching science.

Hagar (1969) wrote a history of planetariums evolution and cited their ever increasing importance in education.

Howarth (1969) wrote that planetariums were a combination of many media that were informative and entertaining.

During the 1960's writers also began to investigate information and research that was of a more specific nature.

Korey (1963) wrote on ways of effectively using the planetarium facilities. Smith (1966) compared the effectiveness of planetarium lecture-demonstrations with a classroom lecture-demonstration and concluded that the classroom was more effective in terms of achievement than one given in the planetarium and that planetarium visits were not essential.

Soroka (1968) studied matched eighth grade classes in terms of spatial relationships. He concluded that the planetarium did not make a significant contribution to the improvement of spatial relations aptitude as determined by testing measures designed to show such change.

Battaglini (1971) studied fourth grade students in concepts of relative position and motion with and without the planetarium. Classes taught in the planetarium showed an analyses of covariance that was significantly greater for those classes not visiting the planetarium.

Sunal (1973) investigated the planetarium in terms of perceived goals. This study indicates the planetarium as typically used for elementary school visitations did not appear uniquely better in any goal area of the planetarium educator when compared to a typical classroom learning situation.

Major issues were pursued in several directions of concern. Research was done to determine the importance of lab oriented in the educational process. Bloom (1971) states the following in this regard:

> One to one relationship between teacher and learner represents the most costly type of help and should be used only where alternative procedures are not effective. However, this type of help should be available to students as they need it, especially where individuals have particular difficulties that can't be corrected in other ways. (p. 39)

Perhaps two students with one telescope in the astronomy lab comes as near a one-to-one teaching relationship, that is economically feasible, as can be found. Bringing a fresh way of viewing the idea or the process, is an answer to the costly one-to-one relationship of student and teacher. The student, through this process, may become skillful in detecting the points of difficulty in his learning and should help him in such a way as to free himself eventually from continued dependence on a classroom situation, but keep the techniques with him always. (Dean, 1971)

Goodlad and Anderson (1959) and Bloom (1971) believe that if every student had a very good method of learning, most of them would be able to learn a particular subject to a high degree. The writers also believed that specific qualities of instruction and motivation are best suited for a specific learner.

Skinner (1958) made a case for observational astronomy in the educational process by pointing out the similarity between programmed instruction and individualized teaching. He pointed out the following good qualities of individualized teaching: (1) Individualized teaching begins where the learner is and does not insist on moving beyond what the learner can

comprehend. (2) Individualized teaching moves at the rate that is consistent with the ability of the learner to learn. (3) Individualized teaching does not permit false answers to remain uncorrected. (4) Individualized teaching does not lecture; instead, by hints and questioning, it helps the student to find and state answers for himself.

With the recent emphasis on accountability for educational programs, both administrators and teachers are faced with the responsibility of justifying every facet of the educational enterprise. Programs and courses in curriculum areas are being clearly defined by measurable objectives. Those programs and courses which no longer meet identifiable needs of students are replaced. Astronomy clearly should not be replaced only refined.

The Pacific Planetarium Association at its spring conference in 1971 proclaimed the planetarium an innovative device which attempts to meet the educational needs of students more effectively than the traditional introductory astronomy classroom. The planetarium, moreover, by virtue of its assumption that its student should be heterogeneous in ability as measured by any of the customary norms, standard scores, grades, or withdrawals makes the additional claim that it can better meet the needs of students who are scientifically interested.

For the purpose of organization, a further review of literature is divided into three parts which are not mutually exclusive. The first deals with the nature of the planetarium, the second

concerns the evaluation of innovative materials and procedures; and the third part considers planetarium programs which relate to this study.

SCIENCE EDUCATION

The origins of the term "general science" in American education are found in the early 19th century when colleges, which had catered primarily to law, medical, and divinity students, responded to pressures to broaden the scope of their curricula. (Thomas, 1962.) For the remainder of the century, there was fluctuation between emphasizing courses with vocational objectives and more general courses in the liberal arts. In either case, students were given wider opportunities to select courses of their own choice. Thus, by the end of World War I, educators, in reaction to the dehumanizing effects of war, moved to curtail the election system and to reinstate courses that would teach basic principles of peace and humanity. (Monroe, 1972.) However, as a measure of security, the knowledge of science was a necessity.

Many of the principles, and in some cases the curricula themselves, of current general science programs derive from the 1920's and 1930's. This period saw a return to the classical curriculum with a liberal arts base. Monroe (1972) identified three main goals that characterized general science programs:

(1) to provide an understanding the technology of Western civilization

(2) to reduce the number of separate, discrete courses offered by using survey courses

(3) to provide a common body of subject matter for all students by using a selection of original sources from the classics or the great books as the basic text materials. (pp. 70-71.)

During the period after World War II, general science enjoyed its widest acceptance. (Cohen, 1969.) There were a number of serious attempts to develop integrated science curricula, such as those offered at the University of Chicago, St. John's College, Michigan State University, the University of Minnesota, and Columbia University. (Thomas, 1962; Cohen, 1969.) Even during this period of broad acceptance of the general science concept, Johnson (1952) and Bogue (1950) found that community colleges in general had not developed integrated scientific programs. Even today, the normal approach to science is to require students to take specified introductory courses.

The late 1950's and the 1960's were again marked by a turning away from general science programs. The space age interest in technology and the need for early specialization fostered programs which focused entirely on developing skills and largely ignored the social and personal development of students. (Cohen, 1969.) In the 1970's, there is increased resistance to the specialization approach to higher education, but economic conditions and widespread unemployment have evoked strong support for programs which will insure employment for graduates. (Cohen, Brawer, and Lombardi, 1971.)

A problem basic to the development of general science has been to define its nature and goals and to determine the

most effective means for achieving those goals (Thomas, 1962.) A survey of science programs reveals a wide diversity in philosophy and consequently in program goals. Perhaps the only agreement is that science education encompasses that area of learning which is essential to and required of all college students (Monroe, 1972.)

Particular definitions of science education have tended to focus on one or more of four reference points in learning: (1) fundamental ideas and principles found in the disciplines; (2) cultural growth through exposure to classic examples of man's learning and art; (3) societal needs; and (4) the individual's growth and effectiveness. Certainly, most colleges have developed science programs by requiring basic introductory courses in the discipline areas. Mayhew (1960) saw this approach as an attempt to give students the overall organization and development of human knowledge. The "great books" approach proposed by Hutchins (1936) was totally implemented by St. John's College as an effort to use the wisdom of the past to nourish cultural growth and to solve contemporary problems. While recognizing the importance of the individual's development, Johnson (1952) addressed scientific needs in his definition: "Technology is a part of education which encompasses the common knowledge, skills, and attitudes needed by each individual to be effective as a person, a member of a family, a worker, and a citizen. (p. 2.) Thornton (1966) emphasized personal fulfillment in his definition of science programs which should be designed "to prepare young people for the responsibilities

that they share in common as citizens of a free society and for wholesome and creative participation in a wide range of life activities." (p. 198.)

Although these different approaches to science education reflect a number of issues, the fundamental conflict seems to be whether science education should be directed specifically at the training of the intellect or at the development of the total individual. (Johnson, 1952.) The position of the colleges of the Pacific Planetarium Association on this issue has direct implications for curriculum development and course requirements. Since the 1950's an increasing number of educators have supported the position that programs should be directed towards the growth of the individual in all areas of his life. Carlin (1964), Thornton (1966), Cohen (1969), Monroe (1972), and Kintzer (1973) have taken positions that in most respects supported the goals of science education held by the Pacific Planetarium Association and many other science education associations:

(1) Science education must be based on the characteristics of students and of society.

(2) All areas of experience, at home and in the community, as well as in the college, interact to affect the student's scientific growth.

(3) The community college will not complete the student's science education; rather it will aim to equip and encourage him to pursue the goals of science education throughout his life.

(4) Student in . . . community colleges differ greatly in experiences, needs, capacities, interests, and aspirations.

(5) The science education program must promote the growth and development of each individual student on the basis of his particular abilities, interests, and other characteristics.

(6) The final test of a program of science education is changed student behavior, motivated by the student's desire to improve himself and society. (Johnson, 1952, pp. 20-21.)

The goals of science education at Pacific Planetarium Association community colleges seem to be directed particularly towards the individual student's personal development. Science departments in their brochures often state an objective of development of critical thinking, effective communication, self-understanding, and satisfying human relationships. (p. 45.) The translation of this objective into appropriate procedures, however, is unclear. The student must often complete a core of courses too heavily laden with English, humanities, and social science courses. Although it is possible, and perhaps even probable, that students will realize the objectives of science education specified, the emphasis on discipline courses which are often historical and theoretical in nature does not seem most supportive of the development of "self-understanding" and "satisfying human relationships." The community college approach to science education essentially follows a core curriculum formula which is common in many states. (Kintzer, 1973.)

It was the dissatisfaction with the abrupt ending of sequential astronomy courses which led to the development of the observational astronomy department specifically designed to meet sequential science education goals. Berg (1968) maintained that students who merely took isolated discipline-oriented courses were not obtaining a general education. This same dissatisfaction caused Mayhew (1969) and Cohen (1971) to reject

approaches using courses that are introductory to disciplines and to support integrated programs. Cohen (1969, p. 84) wrote: "The current distribution requirements, prerequisites for transfer, and university-type specialized offerings simply do not lead to an integrated education of a type that suits the broad purposes of the American community college." Thus, Monroe (1972) believed that the trend in the community colleges will be to reduce required individual courses, the core curriculum approach, but to expand the concept of providing opportunities for students to engage in integrated learning experiences. This is the direction the observational astronomy text has taken.

INNOVATIVE TEXTS, MATERIALS, PROCEDURES

An innovative program as illustrated by Terry O'Banion is one that is new to a community college. Its "newness" does not necessarily imply a complete break from traditional educational programs and teaching strategies, but may result from a new combination, rearrangement, or emphasis of previous procedures. Barnett (1953), Miles (1964), and Brick and McGrath (1969) supported this rather broad understanding of innovation. Innovation in practice is relative, for what may be the most significant, but least accepted reason is to bring enthusiasm and excitement to what easily can become a monotonous process. (Cohen, 1971.)

There has been renewed interest in interdisciplinary programs during the past decade as a means of meeting the

varied needs of community college students. Of sixty-seven responses in a Pacific Planetarium Association survey of colleges, thirty-one indicated both that astronomy was a curriculum innovation and that some form of general physical science was offered by the college. (Spring, 1977.)

The cost of observatories and planetariums is high, and college administrators cannot be satisfied merely with introducing innovative programs. Too often the great amount of energy expended on planning and implementing a new facility reduces the inclination of the developers to evaluate the effectiveness of the facility. This reluctance has been especially apparent with the observatory and the planetarium. It has been stated that administrators of developmental programs have "ignored the responsibility to evaluate their contributions honestly." (Blocker, Plummer and Richardson, 1965, p. 208.) Roueche (1968b) supported this observation when he wrote that "with very few exceptions, little research has been implemented to evaluate the effectiveness of programs and instructors." (p. 41.)

A special difficulty in the evaluation of the innovative planetarium is the determination of valid criteria for evaluation. (Cohen, 1971.) The educational goals of many innovative texts, including those of Pacific Planetarium Association members (Bonneau, Gingerich, Smith) differ in their nature of their emphasis from goals of traditional programs. Thus, the use of the old methods of evaluation may not do justice to innovative programs. (Moore, 1971.) While recognizing the problems with

traditional evaluation criteria, Roueche and Kirk (1973) observed that other clearly defined criteria do not yet exist in the research literature and that the traditional criteria are nevertheless important indices.

The students' grade point averages are one of the criteria that Roueche and Kirk (1973) found still valid for measuring the success of the innovative. In their studies they computed the grade point averages both during the period of the innovative techniques and during the students' subsequent semesters. A publication sponsored by the American Association of Community and Junior Colleges specified that one of the guidelines for accountability is the "evaluation of instruction in terms of student success." (Roueche, Baker and Brownell, 1972, p. 36.) Cohen (1971), however, disparaged the use of grade point averages to measure academic success because he found such grading procedures to be simply a misused process of "sorting." Nevertheless, given a traditional grading system, like the "A" through "F" (changing to a form grade A, B, C, W, in some community colleges), the grade point average seems to be one direct measure of student success.

Student attrition in the sciences has been a particularly serious problem in the community colleges. The "open door" policy used by many community colleges deliberately fosters enrollment by low ability and poorly motivated students. The charge that the community college has become a "revolving door" rather than an "open door" is a serious one. (Medsker and Tillery, 1971; Roueche, Baker and Brownell, 1972.) Medsker

and Tillery (1971) also conservatively estimated that one-third of the students who enter community colleges are soon on the way out. They concluded that there was a great need for comprehensive programs which would provide all students with reasonable opportunities for success.

The rate of attrition provides valuable information for assessing the success of the community college and of science-math courses within the college. Stanley (1971) encouraged colleges to broaden evaluative criteria beyond grade point averages to include dropout rates. He pointed out that high-risk students could be treated separately from regular students and terminal students from transfer students. Roueche and Kirk (1973) thought that persistence of students in the community college might be a more valid indicator of success than grade point averages. Their study of community college programs measured persistence by completion of terms following initial enrollment.

There are, however, problems with using student attrition for evaluation of science courses in the community colleges. Moore (1971) viewed attrition rates as one of the poorest indices, as did Cohen (1971). Moore observed that students withdraw for many reasons other than scholastic ones. He referred to follow-up studies which showed that many students change goals or accomplish goals of which the colleges are unaware. In fact, colleges at times could be performing a positive service to students if they assisted the students in making sound personal decisions which lead to their withdrawal.

One community college follow-up study (Inter-Institutional Research Council, 1973) revealed that the dropout percentage was reduced over 30 percent when students who planned to return to college or who were still pursuing their objectives were excluded. One recommendation in a special report issued by the Carnegie Commission, Less Time, More Options (1971), went so far as to support the option for students to "stop out" from college in order to work on other goals, like work experience. Medsker and Tillery (1971) concluded that because students "do not remain for two years is not of itself cause for criticism, especially if the community college is viewed as a flexible institution capable of serving various types of needs" (p. 51.) Yet, it would seem realistic to expect that innovative texts, materials and procedures might seriously arrest student attrition.

The graduation rate is a statistic related to attrition rate, but it focuses on the success of students who remain in school. Most studies, like those of Roueche and Kirk (1973), treated graduation in terms of perserverance in school. These studies of graduation rates also included a time factor; graduation rates were determined after a specified "normal" period of time, usually after two years in the community college. Moore (1971), Medsker and Tillery (1971), and Roueche and Kirk (1973) have stressed the caution that is necessary when using graduation rate as a criterion of student success, since many students transfer to four-year institution before completing two years at the community college.

The original use of the planetarium by the community college has been the subject of some preliminary research in the past twenty years of its popularity. Student success was measured by using two criteria of success, grade point averages and requests for more astronomy courses. Using a matched group design, Bomgren (1971) compared students from astronomy classes using a planetarium with students from the student body proper. He found some differences in their success rates in particular courses, although any results from tests of significance are not available. In the planetarium, 67 percent were successful in English, 64 percent in social science, and 71 percent in physical science courses. Of the students in the traditional courses, 77 percent were successful in English, 81 percent in social science, and 63 percent in the natural science courses. The planetarium students were lower in the English and social science courses, but higher in physical science courses. Bomgren (1970) also compared those students with twelfth grade aptitude scores at the 25th percentile or below on Santa Ana College norms. Both groups were almost equally successful in English and social science but 65 percent of the planetarium students were successful in the natural science courses compared to 43 percent of the student body proper control group. A comparison of grade point averages after the first academic year showed the planetarium group to have a mean grade point average of 2.57, while the matched control group had a grade point average of 2.31. Again, there are no results from tests of significance available. It is important to note that the

population of Bomgren's studies was drawn from the 1970-71 academic year, early in the operation of the Santa Ana Planetarium as a teaching device.

Another Bomgren (1971) survey analyzed the graduation rate of planetarium students. The population for this study again consisted of students who entered Santa Ana College in the fall term, 1970. The number of graduates was determined at the completion of an academic year, the spring of 1971. The results of this study showed that students in the student body proper graduated in greater numbers than did the planetarium students. Pacific Planetarium Association believes that the data raised as many questions as they answered.

Pacific Planetarium Association research reveals that there is a great need for research on innovative uses of the planetarium. "That instructional effectiveness in total programs is superior to individual classes is not yet clear. (Roueche, 1968b, p. 40.) Although there are serious questions about the validity of traditional measures of student success, especially when applied to innovative courses, no other satisfactory criteria have been developed. Grade point averages, do serve a most useful and important function.

ASTRONOMY CURRICULA

Academic assistance for the low achiever in higher education is becoming a problem of major importance. This problem seems to be more pronounced in the community colleges with the open-door policy and the great diversity of student characteristics.

Cross (1974) states:

> The identity crisis came in the community college when it could no longer select the student body that created the image we wished to project. The image of the establishment of higher education is threatened, not so much by the highly visible issues of affirmative action and civil rights, as by the relatively quiet influx of large numbers of students with poor academic records into open colleges. As I talk about New Students today, I am referring not to the ethnic minorities or to women or to older part-time students, but rather to students of any color or age who are ill-prepared for traditional college study. (p. 31.)

Despite its success, the open-door policy of community colleges has created considerable concern. Dropout rates are high and there is little research to indicate the cause. There is continued skepticism concerning the impact this policy has had on the quality of educational programs. Concerning open admissions, Etzioni (1971) expresses that concern as follows:

> it is unrealistic and, in the long run, harmful to assume that the injection of underprepared students into student body whose general achievement is high can have no effect on the standards or quality of an academic institution, and ...as I see it, the present form of expanding admissions must result in the dilution of academic standards.

Since the post-World War II boom in higher education, it has been the community college which has felt and recognized the great need for some form of remedial education. Remediation has taken many shapes and what research has been done is inconclusive about the overall effectiveness of remedial programs. By 1971, some 30 to 50 percent of the students entering open-door community colleges needed or desired some essential science courses. A study by the Center for Research and Development in Higher Education of the community colleges in

California, Illinois, Massachusetts, and North Carolina, showed that 49 percent of the students scored below the 30th percentile on the Student College Achievement Test in 1965. (Moore, 1971.) It is estimated that by 1980, the number of scientifically disadvantaged students in the public community colleges will be even greater. (Monroe, 1972.)

That there is a great need for programs to offer these students reasonable opportunities for success in math-science courses is clear. Cohen (1969) brought out the distinction between giving students the opportunity to attend college by the open-door policy, and taking an active role in insuring as far as possible that they will learn and will be successful. Roueche (1972) and Medsker and Tillery (1971) have been leading proponents of new programs for the educationally disadvantaged in the community colleges. The typical community college student is educationally disadvantaged in the sciences. Roueche (1972) has encouraged administrators and teachers to develop new programs and approaches which would meet the diverse needs of the disadvantaged. Bonneau (charter president of the Pacific Planetarium Association) acknowledged that there was more experimentation in the area of astronomy curricula but also observed that there was still a need for much greater support of these efforts. Hopefully, attitudes and practices have changed since Griffith Observor (1959) announcement that only 55 percent of community colleges provided astronomy for their students.

Because most of the truly innovative programs for science-interested students are new, research data are sparse. But it may not be the newness that is the problem. For too many programs, evaluation is haphazard and without systematic planning. (Roueche and Kirk, 1973.) A Pacific Planetarium Association Panel on Educational Research and Development in 1969 recommended that formal evaluation procedures be built into the educational system. Few colleges, however, have implemented this recommendation. Roueche (1968b) concluded that "intuition rather than research appears to be the basis for most remedial programs." (p. 42.)

Although many Pacific Planetarium Association instructors have stressed the need for innovative courses, some Pacific Planetarium Association research shows that some innovative astronomy courses have had little or no lasting effect on students. Marasso (1973) found the effects of three planetarium taught courses to be ambiguous. Smith (1971) surveyed two California community colleges and found that the percentages of students passing astronomy using the planetarium were not significantly different. The results obtained for mathematics were more hopeful, but the real effectiveness of the remedial program was uncertain. On the other hand, Evans (1973) did find that students who completed one year in astronomy dropped fewer credits in the first term and were more likely to enroll for a second term. Wright (1971) studied a California community college's astronomy curriculum and found no significant difference in the planetarium students' grade point averages, withdrawal

from college, or achievement in courses. At another California community college fewer than 80 percent of planetarium-trained students returned after the first year, fewer than 35 percent achieved a 2.50 grade point average, and only 37 percent completed the degree work. (McDonald, 1973.)

The astronomy programs at various colleges were selected because they did or did not have planetariums and observatories, but they are not typical of most programs throughout the Pacific Planetarium Association region. It is clear that further research is needed to determine the effectiveness of these programs for the students after they enter the regular college courses, leaving behind the safety of the well-equipped classroom and innovative programs. Roueche's (1968b) earlier conclusions that students in innovative programs may not be sufficiently improved so as to enter regular college courses with confidence of success has not been disproved.

SUMMARY

Much research has been done by astronomy personnel on an individual basis, but there is a lack of organized adequate research on innovative astronomy programs in community colleges. While some initial research has been done on present astronomy courses, the results are inconclusive. It is for this reason that the Pacific Planetarium Association rejected the traditional approach and deliberately desired an innovative educational use of the planetarium for a heterogeneous population. A Pacific Planetarium Association committee concluded that the traditional astronomy students are themselves not a homogeneous group .

There is a need for criteria other than the traditional measures in order to evaluate innovative programs. Nevertheless, the extrinsic indicator of grade point averages is basic to any study. It is especially important that the data obtained using this criterium is not limited to the period when the students participated in innovative programs, but to his community college tenure.

Since the Pacific Planetarium Association (as an educational association) is attempting to meet the needs of the typical community college students and the traditional astronomy (science oriented) students in one, integrated program, it too should heed the recommendation of the Carnegie Commission on Higher Education:

> The Commission recommends that community colleges provide remedial education that is flexible and responsive to the individual student's needs, that such programs be subject to continual study and evaluation, and that community colleges seek the cooperation of other educational institutions in providing for remedial education. (1970, pp. 22-23.)

The Pacific Planetarium Association community college instructors interpret an aspect of remedial to be innovative and inspirational and have tried to remain flexible and to respond to individual needs. But its good intentions must be substantiated by effective student performance. In light of the findings surveyed in the literature, this study attempted to measure in part that performance.

CHAPTER 3

DESIGN OF STUDY

Summary of the Purpose

The purpose of this major applied research project was to determine if the planetarium as a teaching device was superior to the regular classroom for community college students. This chapter will (1) describe the design used to measure academic performance, (2) describe the selection of the population, (3) specify the procedures used to collect data, and (4) state the research hypotheses that were tested.

METHODOLOGY

Three conferences of the Pacific Planetarium Association (fall, 1971; spring, 1972; fall, 1973) considered the community college astronomy student. A quasi-experimental research design of the ex post facto mode described by Campbell and Stanley (1963) was decided upon. The intent of this model is to equate experimental and control groups after the fact by matching them on characteristics found before the treatment. Although this procedure has been used extensively in educational research, Campbell and Stanley pointed out that it has serious weaknesses that threaten its validity. The greatest problem is to match the groups on all the variables that may account for significant differences.

The most satisfactory design, either with a pretest or without one, employs a random assignment of the subjects to

the experimental and control groups. This randomization, however, is impossible in practice in many astronomy teaching situations. Many astronomy instructors resist forcing students into experimental programs solely for the purpose of conducting research. At some of the community colleges of the Pacific Planetarium Association, entering students may elect to enroll in astronomy classes taught in the regular classroom. (e.g., Dr. Garrison at El Camino) Without a commitment of many astronomy instructors to randomization for research purposes, there is no way of avoiding the possible contamination of selection bias. Campbell and Stanley (1963) pointed out that "biases resulting in differential selections of respondents for the comparison groups" were a definite threat to internal validity. (p. 175.) Because of the students' self-selection of programs, the question becomes whether the planetarium treatment made a difference in the outcomes, or whether any differences were really predetermined by the nature of the students who selected to enroll in the planetarium-taught courses. There were, however, some factors which reduced the threat posed by the selection process. Program advisors and instructors agreed that students enrolled in the planetarium classes for many reasons other than the instructional nature of the program. A large number were attracted by time factors and by the block scheduling which guaranteed students ideal morning or afternoon schedules. Other students selected the planetarium when their first choice courses were closed. Students in the planetarium-taught classes were exposed to a special treatment, the planetarium concept

approach. Students in the regular classroom astronomy courses formed the control group. In the study, the students were classified according to grade point averages, and the planetarium students were compared to the regular classroom students. In another classification according to sex, the planetarium-taught male was compared to the regular classroom-taught male. The same was true of the female. Then from each set, students under thirty, thirty to thirty-nine, and forty or over were selected to be the subjects of the study.

Students were also grouped according to ability. Those whose grade point average was below two-point formed the "low ability" group. Students whose grade point average was three-point or above formed the high ability set. Students whose grade point average was two-point to 2.99 composed the medium ability set. This enabled comparisons to be made both between and within planetarium classes and regular classes. The effectiveness of the planetarium instruction was determined by measuring student academic performance.

The criteria for measuring academic performance were: (1) grades and homework, (2) grades on unit tests, (3) grades on mid-term tests, and (4) final course grades.

POPULATION OF THE STUDY

The population of this study was drawn from those students who entered Cerritos and El Camino Community Colleges for the first time in the fall, 1974. Nearly all of those students had graduated from California senior high schools. Less than

50 percent of community college transcripts had available high school grade point averages; and there was strong correlation between this and the community college grade point. The community college grade point average was .4 letter grade higher.

Test scores for 138 planetarium students were reported. A much smaller number of scores were available for students who did not enroll in the planetarium classes as the instructor taught more students in the planetarium. One hundred and seven scores for students in regular classes were available. For the purpose of this study, ninety-six students were selected from those who met all the criteria for the classroom-taught students with 131 meeting the criteria for planetarium-taught students were at the three-point mean or above, and thirty-two regular-classroom students were at the three-point mean or above. The planetarium had seventy-seven students between the two-point and 2.99 mean and the regular classroom had fifty-three students between two-point and 2.99. The planetarium had eight students below the two-point mean and the regular classroom had eleven. The population sizes are found in table 1, and table 2 shows that there was no significant difference between the mean grade point average scores for the planetarium students and those in regular classes.

TABLE 1

Sample Population Sizes of
Planetarium and Regular Classroom Groups

Grade point Group	N eligible for contribution for study	N selected for study	Percent of eligible N in study
Planetarium			
Three-point or higher	57	46	80
Two-point to 2.99	95	77	81
Below two-point	11	8	73
Regular Classroom			
Three-point or higher	37	32	86
Two-point to 2.99	61	53	87
Below two-point	13	11	85

TABLE 2

A Comparison of Grade Point Averages Mean
Percentile Scores for Planetarium and Regular Classroom

Statistic	Planetarium	Regular Classroom	"t"
N	131	96	
Mean	2.763	2.634	0.032*
SD	30.483	29.3612	

*Not significant at .05 level.

After the students who had grade point scores below two-point were identified, they were compared on the four criteria of homework, unit tests, midterm tests, and final course grades. The regular classroom students were from Cerritos Community college. The planetarium students were from El Camino. Various checks on socio-economic ethnic status indicate students of both college were reasonably similar. Both colleges were 70 percent "Caucasian" or "other."

After the planetarium and the regular groups had been selected for academic ability, the populations were examined to determine if there were any significant differences in the achievement of three mean age groups or in the male-female ratios. Almost all the students were recent high school graduates and differences were sought in three grade point mean groups, as seen in table 3. It was not possible to compare the groups in terms of the students' ethnic groups because this information is not provided on the transcript records.

COLLECTION OF DATA

The effectiveness of the planetarium classroom and the regular classroom was measured in terms of academic performance. Although it was necessary to collect data on individual students, group mean scores were used in the community college assessment. Grade point averages, age, and sex were determined by examining each student's transcript of grades.

This study followed the performance of students over a two-year period, the average time required to complete an

TABLE 3

Mean Ages of Planetarium
and Regular Classroom

Age Groups	N	Mean Age Planetarium	N	Regular
Three-point or higher	46	26.6	32	31.7
Two-point to 2.99	77	25.1	53	29.9
Below two-point	8	23.8	11	28.0

The male-female ratios did reveal greater differences, but chi-square analyses showed that these differences were not significant at the .05 level. Table 4 gives the numbers of each sex and the chi-square results.

TABLE 4

Male and Female Distribution
in Planetarium and Regular Classroom Groups

Grade Point Group	Planetarium N	M	F	Regular Classroom N	M	F	Chi Square
Three-point or higher	46	24	22	32	17	15	1.849*
Two-point to 2.99	77	39	38	53	32	21	1.083*
Below two-point	8	5	3	11	6	5	.809

*Not significant at .05 level.

Associate of Arts degree program. The planetarium classes used are one semester classes, almost always taken during the first year of college.

In order to compare planetarium and regular classroom students during the time of the experimental treatment and in specified courses, grade point averages and credits earned were computed through the spring, 1977. Analyses were then made for the first astronomy course, for pre-course grades, post-course grades, and for both combined.

HYPOTHESES

The following hypotheses concerning the students' academic performance were tested in order to assess the effectiveness and evaluation of the planetarium as a teaching device. An analysis of variance was used to test those hypotheses dealing with grade point averages, and achievement according to sex and age. The remainder of the hypotheses were tested by chi-square analyses. A significance at the .05 probability level or less was used for rejecting the null hypotheses.

Homework Achievement Hypotheses

H1: There is no significant difference in homework grades between the planetarium classes and regular classes at the end of the first unit of study.

H2: There is no significant difference in homework grades between the planetarium and regular class students at the end of the second unit of study.

H3: There is no significant difference in homework grades between planetarium and regular classroom students at the end of the third unit of study.

H4: There is no significant difference in homework grades between planetarium and regular classes at the end of the fourth unit of study.

H5: There is no significant difference in homework grades between planetarium classes and regular classroom students at the end of the fifth unit of study.

H6: There is no significant difference in homework grades between planetarium and regular classroom students at the end of the sixth unit of study.

Unit Test Achievement Hypotheses

U1: There is no significant difference in unit test grades between the planetarium classes and regular classes at the end of the first unit of study.

U2: There is no significant difference in unit test grades between planetarium classes and regular classes at the end of the second unit of study.

U3: There is no significant difference in unit test grades between planetarium classes and regular classes at the end of the third unit of study.

U4: There is no significant difference in unit test grades between planetarium classes and regular classes at the end of the fourth unit of study.

U5: There is no significant difference in unit test

grades between planetarium classes and regular classes at the end of the fifth unit of study.

Midterm Achievement Hypothesis

M1: There is no significant difference in midterm test grades between planetarium classes and regular classes.

Course Grade Hypothesis

G1: There is no significant difference in course grade between planetarium classes and regular classes at the end of the semester.

Grade Point Achievement Hypotheses

P1: There is no significant difference in the unit one test grades between the planetarium classes and regular classes for students ranking at the three-point mean or higher.

P2: There is no significant difference in the unit one test grades between the planetarium and regular class students, for students ranking from the two-point to 2.99 mean.

P3: There is no significant difference in the unit one test grades between planetarium and regular classroom students for students ranking below the two-point mean.

P4: There is no significant difference in the unit two test grades between the planetarium and regular classes for students ranking at the three-point mean or higher.

P5: There is no significant difference in the unit two test grades betwen planetarium and regular classroom students for students ranking from the two-point to 2.99 mean.

P6: There is no significant difference in the unit two test grades between planetarium and regular classroom students for students ranking below the two-point mean.

P7: There is no significant difference in the unit three test grades between planetarium and regular classroom students for students ranking at the three-point mean or higher.

P8: There is no significant difference in the unit three test grades between planetarium and regular classroom students for students ranking from the two-point to 2.99 mean.

P9: There is no significant difference in the unit three test grades between planetarium and regular classroom students for students ranking below the two-point mean.

P10: There is no significant difference in the unit four test grades between planetarium and regular classroom students for students ranking at the three-point mean or higher.

P11: There is no significant difference in the unit four test grades between planetarium and regular classroom students for students ranking from two-point to 2.99 mean.

P12: There is no significant difference in the unit four test grades between planetarium and regular classroom students for students ranking below the two-point mean.

P13: There is no significant difference in the unit five test grades between planetarium and regular classroom students for students ranking at the three-point mean or higher.

P14: There is no significant difference in the unit five test grades between planetarium and regular classroom students for students ranking from the two-point to the 2.99 mean.

P15: There is no significant difference in the unit five test grades between planetarium and regular classes for students ranking below the two-point mean.

P16: There is no significant difference in the semester grades between planetarium and regular classroom students for students ranking at the three-point mean or higher.

P17: There is no significant difference in the semester grades between planetarium and regular classroom students for students ranking from the two-point to the 2.99 mean.

P18: There is no significant difference in the semester grades between planetarium and regular classroom students for students ranking below the two-point mean.

Male-Female Achievement Hypotheses

S1: There is no significant difference in unit one test grades between males of the planetarium classes and regular classes at the end of the first unit of study.

S2: There is no significant difference in unit one test grades between females of planetarium classes and regular classes at the end of the first unit of study.

S3: There is no significant difference in unit two test grades between males of the planetarium classes and regular classes at the end of the second unit of study.

S4: There is no significant difference in unit two test grades between females of the planetarium classes and regular classes at the end of the second unit of study.

S5: There is no significant difference in unit three test grades between males of the planetarium classes and regular classes at the end of the third unit of study.

S6: There is no significant difference in unit three test grades between females of planetarium classes and regular classes at the end of the third unit of study.

S7: There is no significant difference in unit four test grades between males of planetarium classes and regular classes at the end of the fourth unit of study.

S8: There is no significant difference in unit four test grades between females of the planetarium classes and regular classes at the end of the fourth unit of study.

S9: There is no significant difference in unit five test grades between males of planetarium classes and regular classes at the end of the fifth unit of study.

S10: There is no significant difference in unit five test grades between females of planetarium classes and regular classes at the end of the fifth unit of study.

S11: There is no significant difference in semester grades between males of the planetarium classes and regular classes at the end of the semester.

S12: There is no significant difference in semester grades between females of the planetarium classes and regular classes at the end of the semester.

Age Group Achievement Hypotheses

A1: There is no significant difference in unit one test grades between planetarium classes and regular classes for students under thirty.

A2: There is no significant difference in unit one test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A3: There is no significant difference in unit one test grades between planetarium classes and regular classes for students forty and over.

A4: There is no significant difference in unit two test grades between planetarium classes and regular classes for students under thirty.

A5: There is no significant difference in unit two test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A6: There is no significant difference in unit two test grades between planetarium classes and regular classes for students forty and over.

A7: There is no significant difference in unit three test

grades between planetarium classes and regular classes for students under thirty.

A8: There is no significant difference in unit three test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A9: There is no significant difference in unit three test grades between planetarium classes and regular classes for students forty and over.

A10: There is no significant difference in unit four test grades between planetarium classes and regular classes for students under thirty.

A11: There is no significant difference in unit four test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A12: There is no significant difference in unit four test grades between planetarium classes and regular classes for students forty and over.

A13: There is no significant difference in unit five test grades between planetarium classes and regular classes for students under thirty.

A14: There is no significant difference in unit five test grades between planetarium classes and regular classes for student thirty to thirty-nine.

A15: There is no significant difference in unit five test grades between planetarium classes and regular classes for students forty and over.

A16: There is no significant difference in semester grades between planetarium classes and regular classes for students under thirty.

A17: There is no significant difference in semester grades between planetarium classes and regular classes for students thirty to thirty-nine.

A18: There is no significant difference in semester grades between planetarium classes and regular classes for students forty and over.

CHAPTER 4

ANALYSIS OF THE DATA

The population, consisting of 131 students from the planetarium classes and 96 students from regular classes was followed through the spring of 1975 in introductory astronomy. All students were taught by the same instructor. The students at each college were compared on community college grade point averages through spring 1977 or until their community college termination. In order to measure the success of astronomy students, the sample populations, students were divided into groups: (1) students who ranked from the 2.00 point mean to, but not including the 3.00 mean, and (2) students who ranked below the two-point mean in community college gradepoint average. The students' transcripts, the source of all data, were examined by the investigator at the community colleges in order to compare the performance of students during the semester in the planetarium and in the regular classroom courses.

The results of the tests of these hypotheses are in four main categories. Hypotheses concerning differences in homework grades are listed H and then number. Hypotheses concerning unit tests grades are listed U and then the number.. Hypotheses concerning mid-term tests earned are listed M and then the number. Hypotheses concerning courses grades are listed G and then the number. In the ensuing tables, five through ten deal with homework. Eleven through fifteen deal with unit tests. Sixteen deals with the mid-term test. Seventeen deals with the final course grades.

HOMEWORK ACHIEVEMENT HYPOTHESES

H1: There is no significant difference in homework grades between the planetarium classes and regular classes at the end of the first unit of study.

H2: There is no significant difference in homework grades between the planetarium and regular class students, at the end of the second unit of study.

H3: There is no significant difference in homework grades between planetarium and regular classroom students at the end of the third unit of study.

Hypotheses H1, H2, and H3 were accepted. Differences in the distributions for the first three units of homework were not significant. Table five through seven are for H1, H2, and H3.

H4: There is no significant difference in homework grades between the planetarium and regular class students at the end of the fourth unit of study.

H5: There is no significant difference in homework grades between planetarium classes and regular classroom students, at the end of the fifth unit of study.

H6: There is no significant difference in homework grades between planetarium and regular classroom students at the end of the sixth unit of study.

Hypotheses H5 and H6 were accpeted. Although the planetarium classes had a greater number of higher scores, none of the differences in letter grades during the fifth and sixth units of homework were significant, as found in tables nine and ten.

TABLE 5

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for First Homework Assignment

Letter Grade Group	Planetarium Classes	Regular Classes	Total
A	16	15	31
B	66	33	99
C	42	34	76
D	1	3	4
F	7	12	19
Total	132	97	229

Chi Square 9.052
Degrees of Freedom 4
Differences in the distributions are not significant
Coefficient of contingency 0.195

TABLE 6

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for Second Homework Assignment

Letter Grade Group	Planetarium Classes	Regular Classes	Total
A	25	20	45
B	54	34	88
C	32	28	60
D	1	0	1
F	15	13	28
Total	127	95	222

Chi Square 1.938
Degrees of Freedom 4
Differences in the distributions are not significant
Coefficient of contingency 0.093

TABLE 7

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for Third Homework Assignment

Letter Grade Group	Planetarium Classes	Regular Classes	Total
A	36	16	52
B	51	38	89
C	24	18	42
D	2	4	6
F	19	22	41
Total	132	98	230

Chi Square 6.449
Degrees of Freedom 4
Differences in the distributions are not significant
Coefficient of contingency 0.165

TABLE 8

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for Fourth Homework Assignment

Letter Grade Group	Planetarium Classes	Regular Classes	Total
A	48	27	75
B	46	20	66
C	9	14	23
D	2	7	9
F	25	25	50
Total	130	93	223

Chi Square 14.240
Degrees of Freedom 4
Test of significance - level of confidence is .01
Coefficient of contingency 0.245

TABLE 9

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for Fifth Homework Assignment

Letter Grade Group	Planetarium Classes	Regular Classes	Total
A	31	27	58
B	51	22	73
C	28	17	45
D	6	4	10
F	18	20	38
Total	134	90	224

Chi Square 6.602
Degrees of Freedom 4
Differences in the distributions are not significant
Coefficient of contingency 0.169

TABLE 10

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for Sixth Homework Assignment

Letter Grade Group	Planetarium Classes	Regular Classes	Total
A	40	24	64
B	28	24	52
C	19	11	30
D	5	4	9
F	34	34	68
Total	126	97	223

Chi Square 2.829
Degrees of Freedom 4
Differences in the distributions are not significant
Coefficient of contingency 0.112

Likewise, there were no significant differences between the groups as unit five showed: Chi-square 6.602, degrees of freedom 4, coefficient of contingency 0.169, and unit six: chi-square 2.829, degrees of freedom 4, coefficient of contingency 0.112. However, H4 must be rejected as chi-square shows 14.240, degrees of freedom 4, a test significance - level of confidence is .01, the coefficient of contingency 0.245. In an analysis of this it was interesting to note: That at this point in the course for the first time the Earth, Moon and Sun were finished and study was directed toward the planets and stars. The planetarium students had observed their motions several times in the planetarium.

UNIT TEST ACHIEVEMENT HYPOTHESES

U1: There is no significant difference in unit test grades between the planetarium classes and regular classes at the end of the first unit of study.

U2: There is no significant difference in unit test grades between planetarium classes and regular classes at the end of the second unit of study.

U3: There is no significant difference in unit test grades between planetarium classes and regular classes at the end of the third unit of study.

There was no significant difference in unit test grades between planetarium and regular classes for U2 and U3; chi-square, degrees of freedom, coefficient of contingency: 4.242, 4, 0.140, and 8.575, 4, 0.191 respectively. However, hypothesis

U1 was rejected. Since there was significant difference in unit test grades during the first unit of study or U1, the overall differences can be attributed to the differences in letter grades during the first unit of homework as the homework was related directly to the unit test.

U4: There is no significant difference in unit test grades between planetarium classes and regular classes at the end of the fourth unit of study.

U5: There is no significant difference in unit test grades between planetarium classes and regular classes at the end of the fifth unit of study.

Hypotheses U4 and U5 were both rejected. As for U4, Table 14 shows chi-square 32,200, degrees of freedom 4, test of significance - level of confidence .001, and coefficient of contingency 0.355. Table 15 shows U5 chi-square 11.062, degrees of freedom 4, test of significance - level of confidence is .05 and coefficient of contingency 0.221. Unit 4 was on the planets and Unit 5 was on the stars. If the planetarium was to be of value in teaching it would be in those two units.

Therefore, planetarium classes have significantly higher performance compared with regular classes at the end of the fourth unit of study. Planetarium classes have significantly higher performance compared with regular classes at the end of the fifth unit of study.

TABLE 11

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for the First Unit Test

Letter Grades Group	Planetarium Classes	Regular Classes	Total
A	57	18	75
B	50	42	92
C	22	17	39
D	3	2	5
F	2	15	17
Total	134	94	228

Chi Square 25.526
Degrees of Freedom 4
Test of Significance - Level of confidence is .001
Coefficient of contingency 0.317

TABLE 12

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for the Second Unit Test

Letter Grades Group	Planetarium Classes	Regular Classes	Total
A	44	28	72
B	39	45	84
C	19	15	34
D	0	0	0
F	14	8	22
Total	116	96	212

Chi Square 4.242
Degrees of Freedom 4
Differences in the distributions are not significant
Coefficient of contingency 0.140

TABLE 13

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for the Third Unit Test

Letter Grades Group	Planetarium Classes	Regular Classes	Total
A	31	20	51
B	72	40	112
C	10	14	24
D	1	2	3
F	16	21	37
Total	130	97	227

Chi Square 8.575
Degrees of Freedom 4
Differences in the distributions are not significant
Coefficient of contingency 0.191

TABLE 14

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for the Fourth Unit Test

Letter Grades Group	Planetarium Classes	Regular Classes	Total
A	69	23	92
B	32	35	67
C	3	12	15
D	10	1	11
F	16	23	39
Total	130	94	224

Chi Square 32.200
Degrees of Freedom 4
Test of significance - Level of confidence is .001
Coefficient of contingency 0.355

TABLE 15

A Comparison of Letter Grades Earned in Introductory Astronomy for Planetarium and Regular Classes for the Fifth Unit Test

Letter Grades Group	Planetarium Classes	Regular Classes	Total
A	21	26	47
B	52	25	77
C	25	14	39
D	0	3	3
F	28	21	49
Total	126	89	215

Chi Square 11.062
Degrees of Freedom 4
Test of Significance - Level of confidence is .05
Coefficient of Contingency 0.221

MIDTERM ACHIEVEMENT HYPOTHESIS

M1: There is no significant difference in midterm test grades between planetarium classes and regular classes.

Hypothesis M1 was rejected. The chi-square was shown to be 35.392, four degrees of freedom, test of significance - level of confidence is .001, the coefficient of contingency is 0.386. The midterm test was given on material covered in Unit one and Unit two. The first two homework assignments and unit test two showed differences in the distributions were not significant. However, differences in unit test two were significant and this no doubt is the reason for the differences in the midterm test to be significant.

Therefore the planetarium classes have significantly higher performance compared with regular classes in midterm grades.

COURSE GRADE HYPOTHESIS

G1: There is no significant difference in course grade between planetarium classes and regular classes at the end of the semester.

Hypothesis G1 was rejected. An analysis of the final grades shows chi-square to be 20.781, degrees of freedom 4, test of significance with level of confidence at .001, coefficient of contingency at 0.283. The final grades were based upon the six homework assignments and only the fourth was significant, also on five unit tests, and the midterm test. Test one, four, five, and the midterm were significant. Tests being weighted three times as heavily as the homework led to a significant distribution of final course grades.

Therefore, planetarium classes have significantly higher performance compared with regular classes in course grade at the end of the semester.

TABLE 16

A Comparison of Letter Grades in Introductory Astronomy for Planetarium Classes and Regular Classes for Midterm Tests

Letter Grade Group	Planetarium Classes	Regular Classes	Total
A	4	1	5
B	25	16	41
C	23	35	58
D	25	37	62
F	34	2	36
Total	111	91	202

Chi Square 35.392
Degrees of Freedom 4
Test of significance - Level of confidence is .001
Coefficient of contingency 0.386

TABLE 17

A Comparison of Letter Grades in Introductory Astronomy for Planetarium Classes and Regular Classes for Course Grade

Letter Grade Group	Planetarium Classes	Regular Classes	Total
A	37	12	49
B	55	32	87
C	20	26	46
D	0	0	0
F	21	36	57
Total	133	106	239

Chi Square 20.781
Degrees of Freedom 4
Test of significance - Level of confidence is .001
Coefficient of contingency 0.283

ANALYSIS OF HOMOGENEOUS DATA

The effectiveness of the planetarium classroom general education program designed for a heterogeneous population has been established. The population, consisting of 131 students from the planetarium classes and ninety-six students from regular classes was followed through the spring of 1975 in introductory astronomy. All students were taught by the same instructor. The groups were matched on community college grade point through spring 1977 or until their community college termination. In order to measure the homogeneous success of astronomy students, the sample populations, students were divided into groups: (1) students who ranked at the three-point mean or higher and (2) students who ranked at the 2.00 point to but not including the 3.00 point mean, and (3) students who ranked below the two-point mean in community college grade point average.

Another comparison was made between planetarium male and regular classroom male, planetarium female and regular classroom female. A third comparison was made among age groups. They were divided into three subsets, those under thirty, a second group thirty to thirty-nine years of age and a third group of forty or older.

The students' transcripts, the source of all data, were examined by the investigator at the community college in order to compare the performance of students during the semester in the planetarium and in the regular classroom courses.

The results of the tests of these hypotheses are in three

main categories. Hypotheses concerning differences in community college grade point averages are listed P and then number. Hypotheses concerning sex grades are listed S and then the number. Hypotheses concerning age are listed A and then the number. Tables 18 through 22 deal with Unit Tests one through five respectively.

GRADE POINT ACHIEVEMENT HYPOTHESES

P1: There is no significant difference in the unit one test grades between the planetarium classes and regular classes for students ranking at the three-point mean or higher.

P2: There is no significant difference in the unit one test grades between the planetarium and regular class students, for students ranking at the 2.00 point to but not including the 3.00 point mean.

P3: There is no significant difference in the unit one test grades between planetarium and regular classroom students for students ranking below the two-point mean.

Hypotheses P1, P2, and P3 were rejected; P1 and P2 at the one percent level of confidence and P3 at the five percent level of confidence. Differences in the distribution for the first three unit exams showed the planetarium class to be significantly higher in performance. See table 18.

P4: There is no significant difference in unit two test grades between the planetarium and regular classes for students ranking at the three-point mean or higher.

P5: There is no significant difference in the unit two test

grades between planetarium and regular classroom students for students ranking at the 2.00 point to but not including the 3.00 point mean.

P6: There is no significant difference in the unit two test grades between planetarium and regular classroom students for students ranking below the two-point mean.

Hypotheses P4 and P5 were accepted. Although the planetarium classes had a greater number of higher scores, none of the differences in letter grades were significant, as found in table 19, for P4 and P5. In the below two-point group, the value of "t" was 4.223 on the basis of it being significant at the .01 level. P6 was rejected. In an analysis of P6 it was interesting to note: That at this point in the course for the first time the earth unit was finished and study was directed toward the moon, the first celestial object. The planetarium students had observed its motion several times in the planetarium. Perhaps visualization is more difficult for the lower grade point average student.

Therefore, planetarium students have significantly higher performance compared with regular classes for unit two test grades for students ranking at below the two-point mean. See table 19.

P7: There is no significant difference in the unit three test grades between planetarium and regular classroom students for students ranking at the three-point mean or higher.

TABLE 18

A Comparison of Astronomy Grades on Unit One Tests for Planetarium Classes and Regular Classes for Each Grade Point Group

Grade Point Group	Planetarium Classes	Regular Classes	"t"
Three-point or higher			
N	46	32	
Mean	43.0217	36.5000	3.159***
SD	5.8329	10.4073	
Two-point to 2.99			
N	77	53	
Mean	39.6623	34.3019	3.089***
SD	7.2982	10.5430	
Below two-point			
N	8	11	
Mean	40.8750	29.4545	2.681**
SD	2.6190	13.1079	

** $p < .05$
*** $p < .01$

TABLE 19

A Comparison of Astronomy Grades on Unit Two Tests for Planetarium Classes and Regular Classes for Each Grade Point Group

Grade Point Group	Planetarium Classes	Regular Classes	"t"
Three-point or higher			
N	46	32	
Mean	39.6956	36.4375	1.432*
SD	7.8792	10.8078	
Two-point to 2.99			
N	77	53	
Mean	35.4805	34.3773	0.417*
SD	11.6548	12,1836	
Below two-point			
N	8	11	
Mean	39.0000	19.0909	4.223**
SD	4.6368	13.8397	

*Not significant
**p< .01

TABLE 20

A Comparison of Astronomy Grades on Unit Three Tests for Planetarium Classes and Regular Classes for Each Grade Point Group

Grade Point Group	Planetarium Classes	Regular Classes	"t"
Three-point or higher			
N	46	32	
Mean	38.2609	28.6563	4.138**
SD	9.9093	9.9706	
Two-point to 2.99			
N	77	53	
Mean	34.1688	28.8490	3.027**
SD	10.9893	8.8220	
Below two-point			
N	8	11	
Mean	25.8750	22.7273	0.554*
SD	11.8895	10.9884	

*Not significant
** $p < .01$

P8: There is no significant difference in the unit three test grades between planetarium and regular classroom students for students ranking at the 2.00 point to but not including the 3.00 point mean.

P9: There is no significant difference in the unit three test grades between planetarium and regular classroom students for students ranking below the two-point mean.

Hypothesis P9 was accepted. Although the planetarium had a greater number of higher scores, none of the differences in letter grades were significant, as found in Table 20. In the three-point or higher group, the value of "t" was 4.138, On the basis of it being significant at the .01 level P7 was rejected. On the same basis P8 was rejected.

Therefore, planetarium classes have significantly higher performance compared with regular classes in the unit three (sun) tests for students ranking at the three-point mean or higher and at the 2.00 point to but not including the 3.00 mean.

P10: There is no significant difference in the unit four test grades between planetarium and regular classroom students for students ranking at the three-point mean or higher.

P11: There is no significant difference in the unit four test grades between planetarium and regular classroom students for students ranking at the 2.00 to but not including the 3.00 point mean.

P12: There is no significant difference in the unit four test grades between planetarium and regular classroom students for students ranking below the two-point mean.

TABLE 21

A Comparison of Astronomy Grades on Unit Four Tests
for Planetarium Classes and Regular Classes for Each Grade Point Group

Grade Point Group	Planetarium Classes	Regular Classes	"t"
Three-point or higher			
N	46	32	
Mean	39.0000	32.3750	6.965**
SD	12.9799	15.4450	
Two-point to 2.99			
N	77	53	
Mean	35.8571	29.8302	0.931*
SD	14.9572	16.5501	
Below two-point			
N	8	11	
Mean	33.0000	18.2727	1.765*
SD	13.3135	14.8758	

*Not significant
** $p < .01$

Hypotheses P11 and P12 were accepted. It should be noted the two-point to 2.99 group had reversed itself in table 21 as contrasted to table 20. In the three-point or higher group the value of "t" at 6.965 had the highest significance of this study. Hence P10 was rejected.

Therefore, planetarium classes have significantly higher performance compared with regular classes for students ranking at the three-point mean or higher for unit four tests.

P13: There is no significant difference in the unit five test grades between planetarium and regular classroom students for students ranking at the three-point mean or higher.

P14: There is no significant difference in the unit five test grades between planetarium and regular classroom students for students ranking at the two-point to but not including the three-point mean.

P15: There is no significant difference in the unit five test grades between planetarium and regular classes for students ranking below the two-point mean.

Hypotheses P13, P14, and P15 were all accepted. Table 22 indicates that grades viewed in all grade point groups for unit test five were practically the same. Thus P13, P14 and P15 were accepted, there being no significant difference between the groups.

P16: There is no significant difference in the semester grades between planetarium and regular classroom students for students ranking at the three-point mean or higher.

P17: There is no significant difference in the semester grades between planetarium and regular classroom students for students ranking at the two-point to but not including the three-point mean.

P18: There is no significant difference in the semester grades between planetarium and regular classroom students for students ranking below the two-point mean.

Hypotheses P16, P17 and P18 were all rejected. Table 23 shows the middle group (two-point to 2.99) responding more favorably to the planetarium than either the high or low grade point average groups, when semester grades are compared, but the planetarium students of all three ability groups had significant differences in performance.

TABLE 22

A Comparison of Astronomy Grades for Unit Five Tests
for Planetarium Classes and Regular Classes for Each Grade Point Group

Grade Point Group	Planetarium Classes	Regular Classes	"t"
Three-point or higher			
N	46	32	
Mean	30.6739	32.6563	0.819*
SD	12.5613	17.6752	
Two-point to 2.99			
N	77	53	
Mean	31.1558	27.3773	1.333*
SD	12.5212	17.6167	
Below two-point			
N	8	11	
Mean	24.7500	22.1818	0.313*
SD	14.2017	18.8671	

*Not significant

TABLE 23

A Comparison of Astronomy Course Semester Grades
for Planetarium Classes and Regular Classes for Each Grade Point Group

Grade Point Group	Planetarium Classes	Regular Classes	"t"
Three-point or higher			
N	46	32	
Mean	4.173	3.313	2.199*
SD	1.387	1.845	
Two-point to 2.99			
N	77	53	
Mean	3.181	2.660	3.225**
SD	1.609	1.704	
Below two-point			
N	8	11	
Mean	2.875	1.636	2.473*
SD	1.833	1.493	

*p < .05
**p < .01

MALE-FEMALE ACHIEVEMENT HYPOTHESES

S1: There is no significant difference in unit one test grades between males of planetarium classes and regular classes at the end of the first unit of study.

S2: There is no significant difference in unit one test grades between females of planetarium classes and regular classes at the end of the first unit of study.

Hypotheses S1 and S2 were both rejected. There was a significant difference in the grades earned in the first unit by the females. The differences in grades earned by the males was less than the females, but it was significant. Perhaps this indicates the male deals more readily with the abstract.

S3: There is no significant difference in unit two test grades between males of the planetarium classes and regular classes at the end of the second unit of study.

S4: There is no significant difference in unit two test grades between females of the planetarium classes and regular classes at the end of the second unit of study.

Hypotheses S3 and S4 were both accepted. T-test scores of 1.416 and 1.695 indicated that grades earned in the second unit by males and females taught in the planetarium were not significant.

S5: There is no significant difference in unit three test grades between males of the planetarium classes and regular classes at the end of the third unit of study.

TABLE 24

A Comparison of Astronomy Grades on Unit One Tests
for Planetarium Classes and Regular Classes for Each Sex Group

Sex Group	Planetarium Classes	Regular Classes	"t"
Male			
N	69	69	
Mean	39.9275	34.8840	3.023*
SD	7.6392	11.4405	
Female			
N	62	27	
Mean	42.0161	33.4444	3.809*
SD	5.5022	10.8980	

*p< .01

TABLE 25

A Comparison of Astronomy Grades on Unit Two Tests
for Planetarium Classes and Regular Classes for Each Sex Group

Sex Group	Planetarium Classes	Regular Classes	"t"
Male			
N	69	69	
Mean	39.1014	33.0724	1.416*
SD	11.5321	13.3562	
Female			
N	62	27	
Mean	38.3710	33.9258	1.695*
SD	8.6905	12.1501	

*Not significant

TABLE 26

A Comparison of Astronomy Grades on Unit Three Tests for Planetarium Classes and Regular Classes for Each Sex Group

Sex Group	Planetarium Classes	Regular Classes	"t"
Male			
N	69	69	
Mean	33.7101	27.5217	3.375*
SD	11.5044	9.5487	
Female			
N	62	27	
Mean	36.6452	29.5185	3.038*
SD	10.4266	9.8559	

*p< .01

S6: There is no significant difference in unit three test grades between females of planetarium classes and regular classes at the end of the third unit of study.

Hypotheses S5 and S6 were rejected. T-test scores of 3.375 and 3.038 were significant at the .01 level. The greater value of the planetarium appeared to be to the males in unit three, as indicated by table 26.

S7: There is no significant difference in unit four test grades between males of planetarium classes and regular classes at the end of the fourth unit of study.

S8: There is no significant difference in unit four test grades between females of the planetarium classes and regular classes at the end of the fourth unit of study.

Hypotheses S7 was rejected and S8 was accepted. The difference consistently favors the planetarium, but almost as consistently is insignificant. For the males 2.937 is significant at the .05 level, and 1.957 for the females is not significant.

S9: There is no significant difference in unit five test grades between males of planetarium classes and regular classes at the end of the fifth unit of study.

S10: There is no significant difference in unit five grades between females of planetarium classes and regular classes at the end of the fifth unit of study.

Hypotheses S9 and S10 were accepted. In unit five modern theory under current discussion having to do with relativity, black holes, time and space warp lends itself but little to

TABLE 27

A Comparison of Astronomy Grades on Unit Four Tests for Planetarium Classes and Regular Classes for Each Sex Group

Sex Group	Planetarium Classes	Regular Classes	"t"
Male			
N	69	69	
Mean	36.3188	28.9275	2.937**
SD	14.3593	16.8706	
Female			
N	62	27	
Mean	37.3064	30.4444	1.957*
SD	13.0354	15.5952	

*Not significant
**$p < .05$

TABLE 28

A Comparison of Astronomy Grades on Unit Five Tests for Planetarium Classes and Regular Classes for Each Sex Group

Sex Group	Planetarium Classes	Regular Classes	"t"
Male			
N	69	69	
Mean	29.6377	27.7536	.678*
SD	13.5807	18.4480	
Female			
N	62	27	
Mean	35.3710	30.5555	1.323*
SD	11.5175	16.9800	

* Not significant

TABLE 29

A Comparison of Astronomy Course Semester Grades
for Planetarium Classes and Regular Classes for Each Sex Group

Sex Group	Planetarium Classes	Regular Classes	"t"
Male			
N	69	69	
Mean	3.231	2.609	2.273*
SD	1.754	1.771	
Female			
N	62	27	
Mean	3.823	3.148	4.218**
SD	1.409	1.819	

*p < .05
**p < .01

explanation in the planetarium. This seems to be confirmed by the findings in Table 28.

S11: There is no significant difference in semester grades between males of the planetarium classes and regular classes at the end of the semester.

S12: There is no significant difference in semester grades between females of the planetarium classes and regular classes at the end of the semester.

Hypotheses S11 was rejected at the .05 level. S12 was rejected at the .01 level. The value of the planetarium was greater to the females at the .01 level, and to the males at the .05 level. Table 29 indicates that T-test value of planetarium instruction for the males was significantly higher twice as often.

AGE GROUP ACHIEVEMENT HYPOTHESES

A1: There is no significant difference in unit one test grades between planetarium classes and regular classes for students under thirty.

A2: There is no significant difference in unit one test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A3: There is no significant difference in unit one test grades between planetarium classes and regular classes for students forty and over.

Hypotheses A1, A2, were rejected and A3 was accepted. T-test value of 4.244 for the under thirty group was significant at the

.01 level. It was the highest value scored by any group in tables 30 through 35. The fact is more intriguing that it should be in the very first test by the youngest group.

A4: There is no significant difference in unit two test grades between planetarium classes and regular classes for students under thirty.

A5: There is no significant difference in unit two test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A6: There is no significant difference in unit two test grades between planetarium classes and regular classes for students forty and over.

Hypotheses A5 and A6 were accepted. The under thirty group showed significantly high difference in unit two, hence A4 was rejected.

A7: There is no significant difference in unit three test grades between planetarium classes and regular classes for students under thirty.

A8: There is no significant difference in unit three test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A9: There is no significant difference in unit three test grades between planetarium classes and regular classes for students forty and over.

Hypotheses A7 was rejected, A8 and A9 were accepted. But the under thirty group showed a little more difference with a t-test value of 3.857. This was significant at the .01 level.

TABLE 30

A Comparison of Astronomy Grades on Unit One Tests
for Planetarium Classes and Regular Classes for Each Age Group

Age Group	Planetarium Classes	Regular Classes	"t"
Under thirty			
N	106	56	
Mean	40.6791	32.8571	4.244**
SD	7.1641	11.9781	
Thirty to thirty-nine			
N	21	31	
Mean	42.6190	36.9032	2.877**
SD	4.2144	9.5896	
Forty or over			
N	4	9	
Mean	38.2500	36.2222	.399*
SD	5.8470	10.7267	

* Not significant
**$p < .01$

TABLE 31

A Comparison of Astronomy Grades on Unit Two Tests for Planetarium Classes and Regular Classes for Each Age Group

Age Group	Planetarium Classes	Regular Classes	"t"
Under thirty			
N	106	56	
Mean	36.7924	31.2679	2.662**
SD	10.4860	13.3918	
Thirty to thirty-nine			
N	21	31	
Mean	38.3333	36.2258	0.651*
SD	10.2323	12.5485	
Forty or over			
N	4	9	
Mean	41.2500	36.0000	1.287*
SD	3.9607	9.5568	

*Not significant
**$p < .01$

TABLE 32

A Comparison of Astronomy Grades on Unit Three Tests for Planetarium Classes and Regular Classes for Each Age Group

Age Group	Planetarium Classes	Regular Classes	"t"
Under thirty			
N	106	56	
Mean	33.9151	27.2143	3.857**
SD	11.9489	9.5557	
Thirty to thirty-nine			
N	21	31	
Mean	40.5714	28.7419	.725*
SD	2.8714	9.8209	
Forty or over			
N	4	9	
Mean	37.7500	31.2222	1.761*
SD	3.1918	9.0894	

*Not significant

**$p < .01$

TABLE 33

A Comparison of Astronomy Grades on Unit Four Tests for Planetarium Classes and Regular Classes for Each Age Group

Age Group	Planetarium Classes	Regular Classes	"t"
Under thirty			
N	106	56	
Mean	36.7170	27.8393	3.423**
SD	13.7907	16.9461	
Thirty to Thirty-nine			
N	21	31	
Mean	37.6667	31.5806	1.535*
SD	13.5729	13.9935	
Forty or over			
N	4	9	
Mean	34.0000	31.1111	0.311*
SD	13.3604	14.6397	

*Not significant
**$p < .01$

A10: There is no significant difference in unit four test grades between planetarium classes and regular classes for students under thirty.

A11: There is no significant difference in unit four test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A12: There is no significant difference in unit four test grades between planetarium classes and regular classes for students forty and over.

Hypotheses A10 was rejected, A11 and A12 were accepted. The under thirty group were still consistent with a t-test value of 3.423 significant at the .01 level. It seems to lend credence to the belief the impressionable young are more easily stimulated.

A13: There is no significant difference in unit five test grades between planetarium classes and regular classes for students under thirty.

A14: There is no significant difference in unit five test grades between planetarium classes and regular classes for students thirty to thirty-nine.

A15: There is no significant difference in unit five test grades between planetarium classes and regular classes for students forty and over.

Hypotheses A13, A14, and A15 were accepted. Table 34 indicates once again perhaps the planetarium is of less value in the presentation of abstract theory such as general relativity. None of the age groups showed significance.

A16: There is no significant difference in semester grades between planetarium classes and regular classes for students under thirty.

A17: There is no significant difference in semester grades between planetarium classes and regular classes for students thirty to thirty-nine.

A18: There is no significant difference in semester grades between planetarium classes and regular classes for students forty and over.

Hypotheses A16 and A18 were rejected. Hypothesis A17 was rejected. In the course grade the under thirty group still showed the greatest significance. Table 35 shows the t-test value to be 2.271 which is significant at the .01 level. Only in the midterm did the under thirty group fail to show significance.

TABLE 34

A Comparison of Astronomy Grades on Unit Five Tests for Planetarium Classes and Regular Classes for Each Age Group

Age Group	Planetarium Classes	Regular Classes	"t"
Under thirty			
N	106	56	
Mean	31.8396	26.5714	1.864 *
SD	13.4867	18.5365	
Thirty to thirty-nine			
N	21	31	
Mean	37.8095	31.8710	.487*
SD	10.8172	17.3014	
Forty or over			
N	4	9	
Mean	38.2500	48.3333	1.623*
SD	4.3229	16.0969	

*Not significant

TABLE 35

A Comparison of Astronomy Course Semester Grades for Planetarium Classes and Regular Classes for Each Age Group

Age Group	Planetarium Classes	Regular Classes	"t"
Under thirty			
N	106	56	
Mean	3.415	2.607	2.721***
SD	1.676	1.829	
Thirty to thirty-nine			
N	21	31	
Mean	3.905	3.0654	1.830*
SD	1.444	1.795	
Forty or over			
N	4	9	
Mean	4.000	2.667	2.529**
SD	0.0	1.491	

*Not significant
**p< .05
***p< .01

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS

Introductory Astronomy is a part of the general education curriculum serving student bodies of every ability level and in almost all of the community colleges. The ISPE (International Society of Planetarium Educators), and the Pacific Planetarium Association have attempted to make introductory astronomy innovative in the community colleges in which its influence is felt. Much research has been done by planetarium educators that would validate new methods and courses that have been implemented to improve the quality of the education provided. These research efforts, however, have been done almost in their entirety by individual planetarium educators concerned with visiting grade school children. This study in concerned with the community college student.

The transcripts from El Camino Community College and Cerritos Community College contributed information leading to the analyses of the hypotheses used to answer the following questions that were posed in Chapter One. In this chapter the results of the analyses of the hypotheses are used to answer the research questions listed in Chapter One. These answers are then used to evaluate the success of planetarium conducted classes.

Question 1: Was the difference of academic performance of the students in the planetarium as measured by grade point averages, significantly higher than the performance of comparable

students instructed in the regular classroom?

As a result of the examinations of three groups: (1) grade point (divided into three subgroups); (2) male and female; (3) age (divided into three subgroups), it is concluded that the performance of the planetarium students was consistently higher to the regular classroom students and significantly so on the fourth unit homework, unit tests one, four and five, the mid-term test, and in the final course grade. It was not significantly higher on the units involving earth, moon, sun or planets. This significance showed in the three-point mean or above. This conclusion is evidenced by the chi-square tables five through seventeen.

Question 2: Was the difference of academic performance of the planetarium students who ranked at three-point or higher significantly higher than the performance of comparable students who were in the regular classroom?

Over the period of this study the performance of planetarium students who had scored at the three-point mean or higher was significantly higher than that of comparable students who were not in the planetarium group. This planetarium group had an overall higher mean on unit two and unit five. However, the means for unit one, three and four were significant. The final course grades for these significant differences can be attributed to the first study of celestial bodies (sun, moon, planets) when the students were making first practical use of planetarium instruction. In those units there were statistically significant

differences between planetarium classes and regular classes. In the course grade also there were significant differences for the high ability students.

Question 3: Was the difference of academic performance of planetarium students who ranked at grade point 2.00 to but not including 3.00 significantly higher than that of comparable students in the regular classroom?

A comparison of the performance of the planetarium students who ranked at grade point 2.00 to but not including 3.00 showed that this difference was significant not only in unit one (earth) and unit three on the sun, but also in the final course grade. While the planetarium classroom mean was increasing from 1.8 to 2.1, the regular classroom group decreased substantially from 2.3 to 2.1. This change in averages between planetarium instructed and the regular classroom was significant. Similarly, the planetarium group increased in mean almost twice as much in the course grade. This difference did not reflect the leveling tendency that was characteristic in other units. The planetarium superiority although consistent, was significant twenty-three of fifty possible scores.

Question 4: Was the difference of academic performance of students who ranked below two-point from the planetarium classes significantly higher than that of comparable students in the regular classrooms?

Although the performance of planetarium students who ranked below the two-point mean category was higher than that of comparable students in the regular classroom over the period of study, it was

statistically significant in unit one (earth) and unit three (sun). When these students were compared after having completed instruction in the planetarium their difference of performance, based on final course grades was also better than that of the regular classroom students.

Question 5: Was the difference of academic performance of male students who completed their introductory astronomy course in the planetarium significantly higher than that of comparable students who had been instructed in the regular classroom?

Testing of the hypotheses indicated that the difference of academic performance of the planetarium male group was significantly higher than that of comparable students who had been instructed in the regular classroom. The planetarium male scored significantly higher than did the regular classroom male. During the expected increase units (celestial demonstrations in the planetarium, stars and galaxies) there were no differences that were significant, but over the period of study that planetarium group showed a difference of performance higher, and statistically significant in the final course grade.

Question 6: Was the difference of academic performance of female students who completed their introductory astronomy course in the planetarium significantly higher than that of comparable students who had been instructed in the regular classroom?

Both planetarium and regular classroom female groups showed a decrease in grade point average in the second unit compared

with the first. While the planetarium class decrease was slight, -0.3, the regular class decrease was over one-half letter grade, -0.7. Both the planetarium and the regular classroom students earned lower averages per student in the third unit of study. Although the performance by the planetarium group was better for all units and significantly higher in unit one and three, the course final grade was not statistically significantly higher.

Question 7: Was the difference of academic performance of planetarium students who were under thirty years of age significantly higher than that of comparable students in the regular classroom?

The academic performance of planetarium students who were under thirty years of age was significantly greater than that of comparable students from regular classes. There was significant difference in the means between the two in units one, two, three and four (earth, moon, sun, planets). The overall difference in course grades indicated by the planetarium's t-test indicated advantage over the regular classes was significant at the .01 level. On the basis of the four units of study and of final course grades, there was significantly higher performance of the planetarium students over the regular classroom students.

Question 8: Was the difference of academic performance of planetarium students who were from thirty to thirty-nine years of age significantly higher than that of comparable students in the regular classroom?

Both of the younger groups had a slightly lower mean than

the over forty group. The slight difference between the planetarium and regular classroom was significant only for the first unit (earth). A comparison of the three age groups indicated the planetarium has least significance in this age group. A last place being three, the ranking of this group was 2.67. The differences in unit work and final grade was, again, not significant. The academic performance of planetarium students in the thirty to thirty-nine age bracket was significantly higher than the academic performance of the students in the regular classroom in only one unit.

Question 9: Was the difference of academic performance of planetarium students who were forty years of age and over significantly higher than that of comparable students in the regular classrooms?

A comparison of the significance of planetarium instruction indicates the older student ranks right in the middle in the matter of significance. There was no significant difference between planetarium students and the regular classroom students in the forty and over age group for any one unit. However, the final course grade showed a significant difference for the planetarium student over the regular classroom student.

CONCLUSIONS

Over the period tested, thirty-seven of the 135 planetarium students received A (28 percent) compared to twelve of the regular classroom group of 106 (11.3 percent). From the regular group, thirty-two students received B (30 percent) compared to fifty-five

(40 percent) from the planetarium group. Twenty students from the planetarium group received C (45 percent) while the regular classroom group had twenty-six C's nearly 25 percent. In grades less than C the planetarium group had twenty-one, a score of 27.5 percent and the regular classroom group had thirty-six or a percentage of 34. It was in the comparison of the grade point groups that planetarium instruction was most significant. Four scores of significance of planetarium instruction was in the three-point mean or higher out of a possible six. The first three units deal with earth, moon, sun. The medium ability student showed significance only in unit one, unit three, and the final course grade. Planetarium instruction showed significance for the under two-point mean group in unit one, unit two and the final course grade. On the basis of these results, it may be stated planetarium students consistently scored higher, and significantly so in twenty-three of a possible forty-eight tests.

The assumption was made that grade point earned was a valid index of student academic success and this would indicate the effectiveness of planetarium instruction in comparison to a regular classroom instruction. There are certainly other significant criteria of the effectiveness of planetarium instruction, especially those criteria which measure more significantly the specific goals of the program.

Nevertheless, the findings of this study supported the following general conclusions about the effectiveness of planetarium instruction for homogeneous population at a community college:

1. There is a significant difference in the academic performance of the low ability students who completed astronomy in the planetarium and the performance of those students who had been instructed in the regular classroom astronomy.

2. The difference of academic performance of medium ability students who enrolled in planetarium instruction is significantly higher than that of comparable students in regular classroom instruction.

3. High ability students, those who score in the three-point and above mean on the community college grade point average are more successful academically in planetarium instruction than comparable students who are instructed in the regular classroom.

4. The difference of academic performance of male students, who had planetarium instruction tends to be significant when compared to regular classroom students.

5. The difference of academic performance of female students, who had planetarium instruction tends to be significant when compared to regular classroom students.

6. The difference of academic performance of students under the age of thirty who had planetarium instruction tends to be significant when compared to regular classroom students.

7. The difference of academic performance of students age thirty to thirty-nine who had planetarium instruction tends to be significant when compared to regular classroom students.

8. The difference of academic performance of students age forty and over who had planetarium instruction tends to be significant when compared to regular classroom students.

IMPLICATIONS

The conclusions reached through the combined data of the community colleges involved were: the planetarium instructed community college students were significantly higher in academic performance when compared to the regular classroom instructed students. The evidence of this study indicated that high ability students had a greater opportunity to be successful as measured by academic norms. It was interesting to note, that while the planetarium instruction showed significantly higher performance on less than fifty percent of the tests on no occasion did the regular classroom show superior performance in any degree. For this reason, the long range effectiveness of planetarium instruction is favored. Another factor to be considered is that the planetarium like many special programs, has gone through an evolutionary process since its beginning. The purpose of changes in the planetarium was to improve its educational effectiveness for the community college. Thus, this study of one comparison of students should rightfully be only one aspect of a general program evaluation.

As a result of the findings of this study with respect to planetarium and regular classroom instruction it is recommended that:

1. Support for planetarium instruction be continued.
2. The Physical Science Division offer additional astronomy courses for a second semester of study, so that some students may have the continued opportunity

to be more successful than they might be in the college's regular classroom programs. An honors course for the high academic ability student is indicated.

3. The administration recommend significant aspects of planetarium instruction like the offering of varied learning activities and invitations for consideration by instructors in colleges without planetariums.
4. The planetarium instructors incorporate into the planetarium features which will enable students, especially those of low and medium ability, to gain more from planetarium teaching.
5. The instructors in planetarium instruction implement a system of communication with regular classroom instructors so that students who encounter subsequent difficulty in topics that are better treated in a planetarium may have the opportunity of a planetarium session.

It is recommended that additional research be done, especially to examine the following:

1. The effectiveness of planetarium instruction with respect to its specific goals.
2. The effectiveness of planetarium and regular classroom instruction using the criteria of this study, for students on the same campus.
3. The effectiveness of planetarium and regular classroom instruction using the criteria of this study, for students of various socio-economic strata.

4. The academic success of planetarium students who transferred to upper division colleges and universities.
5. The reasons students withdrew from planetarium instruction as compared to the reasons students withdrew from the regular classroom instruction.
6. The reasons low and medium ability students experienced less success than the high ability students.
7. The effectiveness of individual features of the planetarium classes like the examination of a closely simulated object.
8. Any differences in personality or attitude between planetarium instructors and instructors in the regular classroom.

Because the students in the population of this study selected to enroll or not to enroll in planetarium instruction, it cannot be concluded definitely that planetarium instruction itself was the cause of the consistent and significantly higher academic performance of planetarium students. Likewise, because of the success of planetarium students it cannot be concluded that planetarium instruction is superior to regular classroom instruction because of its physical mobility. Nor did this study identify those aspects of planetarium instruction which were most influential in the students academic performance. This study did show that a group of students were more successful academically than a comparable group of students who enrolled in the regular classroom instruction. That community colleges continue to support and encourage planetarium efforts

as warranted by the results of this study. It is important that efforts to improve the quality of science education, for all students who enter the community colleges, be continued.

SIGNATURE PAGE

I certify that I have read and am willing to sponsor this Major Applied Research Project submitted by Edward D. Ortell. In my opinion it conforms to acceptable standards and is fully adequate in scope and quality, as a Major Applied Research Project for the degree of Doctor of Education at Nova University.

Terry O'Banion, MARP Advisor

I certify that I have read this Major Applied Research Project and in my opinion it conforms to acceptable standards for a Major Applied Research Project for the degree of Doctor of Education at Nova University.

Jerry Garlock, Associate Dean, Research, El Camino College

This Major Applied Research Project was submitted to the Central Staff of the Nova University Ed.D. Program for Community College Faculty and is acceptable as partial fulfillment of the requirements for the degree of Doctor of Education.

Leland Medsker
Central Staff Committee Member

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